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NEW ENGLAND DIV AUG 78

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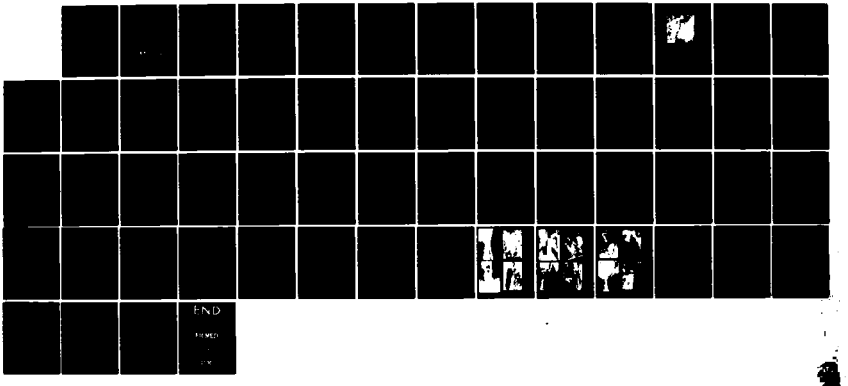

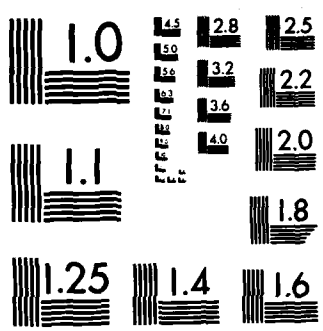

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MERRIMACK RIVER BASIN

NASHUA, NEW HAMPSHIRE

HOLT DAM
NH 00327

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST 1978

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Nashua, New Hampshire
Pennichuck River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

THe dam is a small stone masonry and timber structure with earth embankments located on the Pennichuck River. The dam is assessed to be in fair condition. The dam has erosion problems in several areas and extensive tree growth on embankments. It is small in size with a low hazard potential. Action recommended includes repairing erosion damage and removal of threatening trees and brush.

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HOLT DAM

NH 00327

MERRIMACK RIVER BASIN
NASHUA, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam Holt Dam

State Located New Hampshire

County Located Hillsborough

City or Town Nashua and Merrimack

Stream Pennichuck River

Date of Inspection 6/7/78 and 7/12/78

Brief Assessment

Holt Dam is a small stone masonry and timber structure with earth embankments located on the Pennichuck River on the boundary between Nashua and Merrimack, N.H. The spillway length is 38 feet and the dam's height is 11 feet. Original construction took place in the 1800's, and the dam was rebuilt into its present configuration around the turn of the century. It is operated as part of the water supply for the City of Nashua. Due to its low height, small impoundment, and non-threatening position
hazard structure.

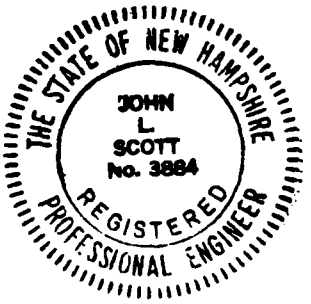
Holt Dam is assessed to be in overall fair condition. The dam has erosion problems in several areas and extensive tree growth on embankments. These worsening situations could lead to future problems if not remedied. However, no gross instability exists at the present time and the dam appears to have been kept in reasonable repair.

The spillway of Holt Dam is capable of just passing the current flood of record, 525 cfs in March, 1936. Though this flow is small for a test flood, the nature of the project leads to the conclusion that the spillway is adequate. The probable maximum flood (PMF) is many times larger, but is not considered applicable, due to the small size and very low hazard potential of this project.

Action recommended includes repairing erosion damage and removal of threatening trees and brush. The owner should take these actions within two years after receipt of this Phase I Report.

WHITMAN & HOWARD, INC.

T.T. Chiang, PhD., P.E.



John L. Scott, P.E.

This Phase I Inspection Report on Holt Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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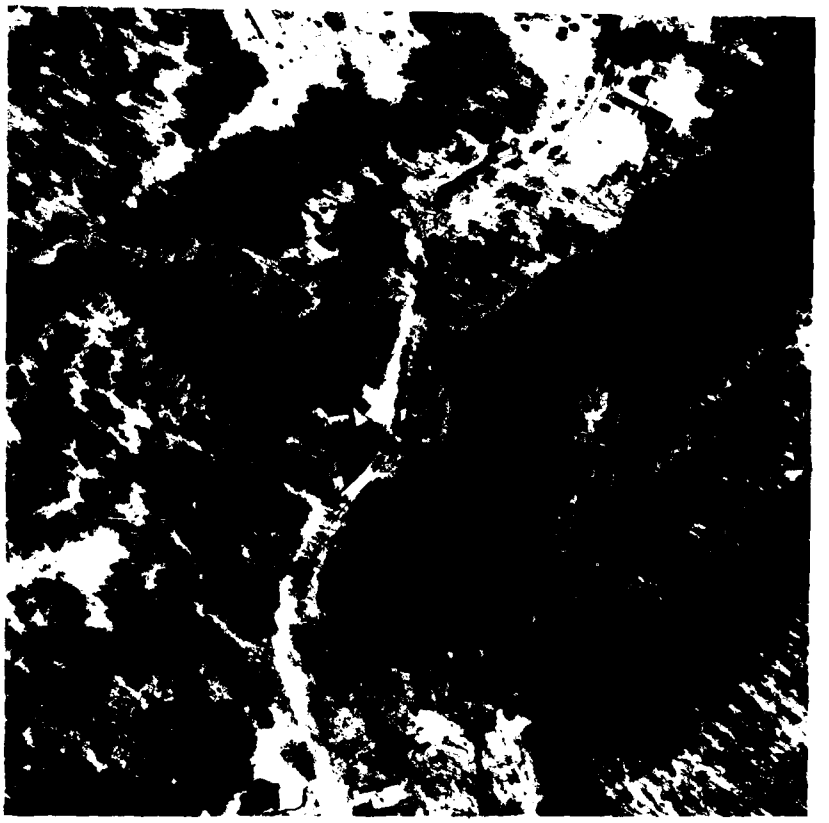
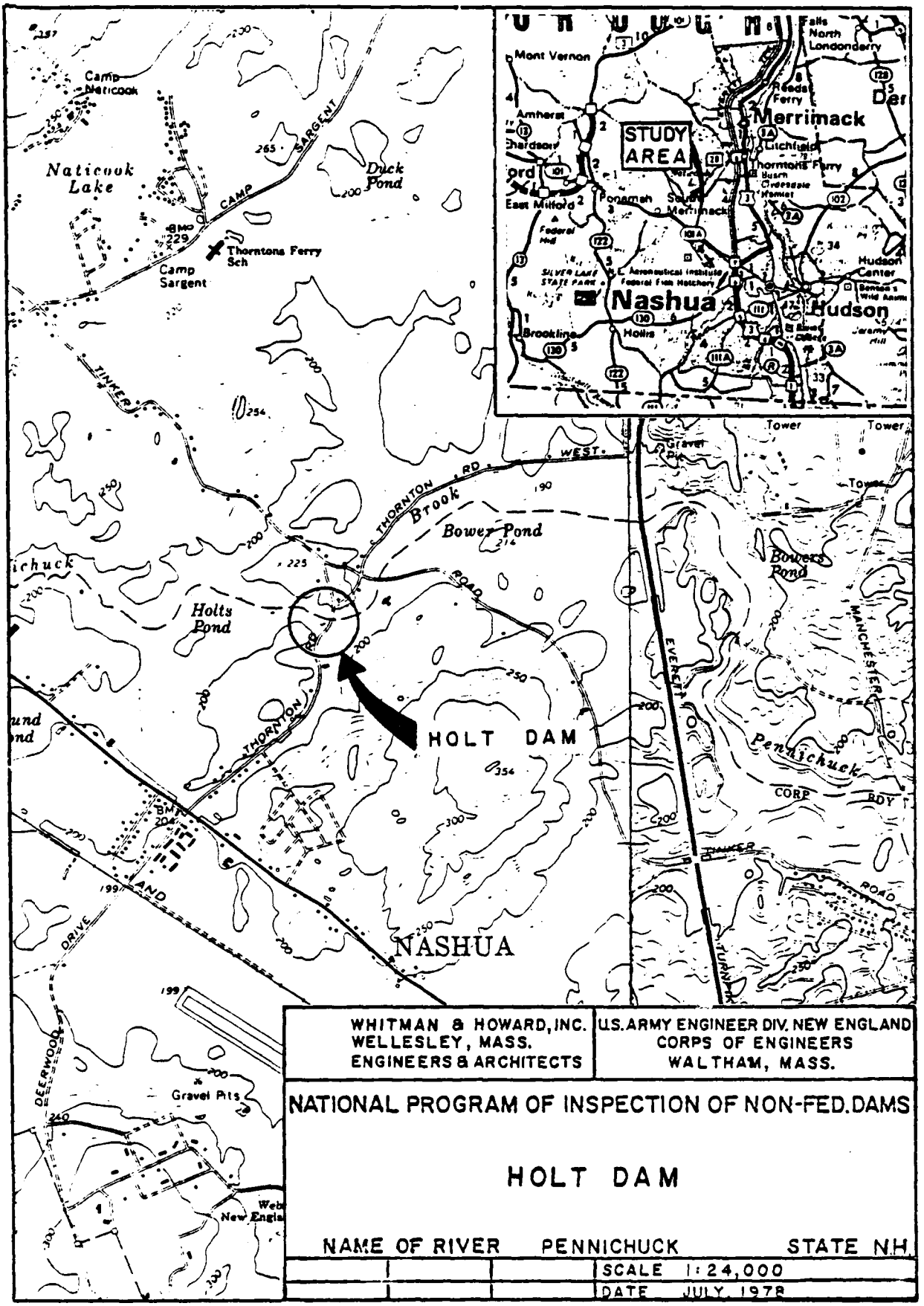


HOLT DAM

Nashua - Merrimack, N.H.

Approx. Scale 1" = 280'



WHITMAN & HOWARD, INC. WELLESLEY, MASS. ENGINEERS & ARCHITECTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

HOLT DAM

NAME OF RIVER PENNICHUCK STATE NH

SCALE 1:24,000

DATE JULY 1978

PHASE I INSPECTION REPORT

HOLT DAM I.D. No. NH00327

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Whitman & Howard, Inc., Engineers & Architects, has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Whitman & Howard, Inc. under a letter of May 3, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0313 has been assigned by the Corps of Engineers for this work.

b. Purpose.

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and prepare the states to quickly initiate effective dam safety programs for non-Fe-eral dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project:

a. Location

Holt Dam is located on the Pennichuck River (a tributary of the Merrimack River) and spans the boundary between the City of Nashua and the Town of Merrimack, N.H. The dam appears at the east end of Holts Pond on the USGS quadrangle "South Merrimack, N.H.".

b. Description of Dam and Appurtenances

Holt Dam is a stone masonry and timber structure with earth embankments. The spillway and crest, of length 38 feet, are of creosoted timber with a timber sheeting cutoff. There are no provisions for flashboards. The abutments are of stone masonry, and through the left abutment is a 2'2" x 3'0" sluice with gatehouse above. The invert of the sluice is 8'3" below the crest. The gatehouse contains automatic level recording equipment. The south embankment has a stone masonry core wall, although the full extent is uncertain. The north abutment joins an earth section which may be natural ground. From there, a short earth embankment with Thornton Road across the crest completes the dam.

c. Size Classification

The low dam height and small volume of impoundment place Holt Dam squarely in the "Small" size classification.

d. Hazard Classification

Holt Dam discharges directly into Bowers Pond, another water supply impoundment downstream. The low height and volume of a flood wave produced by a failure of Holt Dam would probably not do much damage to Bowers Dam. A bridge carrying Thornton Road over the tailwater of Holt Dam has such a small waterway opening that it would probably be washed out by a moderate flood, even if Holt Dam were not there. It is therefore concluded that Holt Dam is in the "Low" hazard class.

e. Ownership

The dam is owned by the Pennichuck Water Works, the public water utility for the City of Nashua.

f. Operator

Augustus Grikas, chief engineer
Pennichuck Water Works
11 High St.
Nashua, N.H. 03060 603/882-5191

g. Purpose of Dam

The impoundment forms part of the water supply for the City of Nashua. It is used at present as the injection point for water treatment chemicals.

h. Design & Construction History

Holt Dam is the uppermost in a series of water supply dams on the Pennichuck River owned by the Pennichuck Water Works, the publicly-owned water utility for the City of Nashua. Some notes place the original construction before 1840 and indicate that it was purchased in 1866 for use as water supply. The dam was rebuilt into its present configuration in either 1890 or 1900. The 1936 flood severely taxed the spillway capacity and the dam may have been overtopped. The abutments may have been raised slightly in 1938 and the timber portions have been restored several times.

In recent years the Water Works has installed a chemical feed system which injects alum through a perforated pipe laid along the crest. A block building to house the chemical tank was erected on the left embankment within the last decade.

i. Normal Operational Procedure

All flow is allowed to pass over the spillway. The discharge gate is seldom operated. The owner injects water treatment chemical into the water thru a perforated pipe laid along the spillway crest. Level is recorded on a chart in the gatehouse.

1.3 Pertinent Data

a. Drainage Area- Total drainage area is 21.1 sq. mi. The upper portion is rolling and the lower portion is flat with a few ponds. No significant dams lie upstream.

b. Discharge at Damsite

(1) Maximum known flood at dam site-525 cfs, Mar. '36

(2) Discharge conduit capacity

	Elev.	Flow, cfs
Spillway crest	183.03	85
Top of Dam	185.7	100

(3) Ungated spillway capacity at maximum pool elev. - 570 cfs.

(4) Total capacity of spillway plus conduit-670 cfs.

c. Elevation (ft. above MSL)

(1) Top Dam - 185.7

(2) Maximum pool-design surcharge - N/A

(3) Full flood control pool - N/A

(4) Recreation pool - N/A

(5) Spillway crest - 183.03

(6) Upstream invert discharge conduit-approx. 174.7

(7) Streambed at centerline of dam - approx. 174.

(8) Maximum tailwater - Not computed.

d. Reservoir

(1) Length of maximum pool - Approx. 2,550 ft.

(2) Length of normal pool - 2,500 ft.

(3) Length of flood control pool - N/A

e. Storage (acre-feet)

(1) At spillway crest pool elev.-180 acre-ft. (est.)

(2) At top of dam pool elev. - 240 acre-ft. (est.)

f. Reservoir Surface (acres)

(1) Top Dam - Approx. 38 acres

(2) Spillway crest - 35 acres

g. Dam

(1) Type - Gravity. Stone masonry with earth fill. Timber spillway and timber cutoff.

(2) Length - Approx. 230 ft.

(3) Height - Maximum 11 ft.

(4) Top Width - Varies

(5) Side Slopes - Vertical stone walls. Embankment slopes vary.

(6) Zoning - Unknown

(7) Impervious Core - Unknown

(8) Cutoff - Spillway has timber cutoff.

(9) Grout curtain - N/A

h. Discharge Conduit

(1) Type - 3' x 2.2' rectangular culvert.

(2) Length - Thru dam, about 10 ft.

(3) Closure - Sluice gate

(4) Access - Gatehouse on left abutment

(5) Regulating Facilities - Handwheel, manual operation.

i. Spillway

(1) Type - straight slope, creosoted timber planks

(2) Length of weir - 38 ft.

(3) Crest Elevation - 183.03 ft. msl

(4) Gates - None - no flashboards

(5) U/S Channel - None as such.

(6) D/S Channel - Discharge under small highway bridge into Bowers Pond.

j. Regulating Outlets - None

SECTION 2: ENGINEERING DATA

2.1 Design

The only design related data available is a sketch by Metcalf and Eddy, Engineers, dated 1914 reportedly showing the dam "as rebuilt, 1890". It is not clear from the drawing whether Metcalf and Eddy was involved in the rebuilding or not. Holt Dam is a small gravity structure of earth fill held in place by vertical stone walls. The spillway and some pertinent structures are of creosoted timber.

2.2 Construction

No records exist of the original construction. It is unclear when, exactly, the structure was built.

Extensive masonry repairs were made in 1936, though the information is in note form and is sketchy. There are vague references to raising the abutments in 1938, though it is not clear whether this was done or not. Within the past decade a chemical feed system was implemented including the construction of the block building on the left abutment to house the chemical feed tank. No details of this system were uncovered.

2.3 Operation

Records have been kept of flood flows at peak times from 1936 to the present and regular level recordings are kept.

2.4 Evaluation

a. Availability

Poor. Little data exists which bears upon a present day evaluation. Most data which was reviewed was in the possession of the owner.

b. Adequacy

Poor. The evaluation must be based solely on the visual inspection.

c. Validity

Fair. The flow records seem valid, and the plan sketch approximately matches the existing structure.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The overall impression of Holt Dam is that of a small structure of obviously low hazard potential. The inspection notes are contained in the check list in Appendix A.

b. Dam

From south to north, the dam consists of a short earthen embankment section at the south abutment, a wooden overflow spillway, a section that may be natural ground (which rises toward a bedrock knob a short distance downstream), and another short embankment section at the north abutment.

c. Appurtenant Structures

The concrete block building for the chemical feed plant is quite new and appears in excellent condition. The gatehouse atop the left abutment is of wood frame construction and is in fair to good condition. The level recorder inside is in place and functioning. The gate for the discharge conduit is reported to be in good operating order, though operation was not witnessed by the inspection team.

d. Reservoir Area

The small reservoir area is wooded and undeveloped.

e. Downstream Channel

The small highway bridge over the tailwater has a small opening which would probably be inundated even before the spillway capacity is reached. The bridge itself is in poor condition.

A thick layer of floating scum was present in the tailwater between the spillway and the small highway bridge. This material is a by-product of the chemical addition process, according to the water works engineering staff.

3.2 Evaluation

Trespassing on the embankment between the spillway and south abutment has resulted in a loss of most of the vegetation, and erosion is actively occurring on its downstream slope next to the wall on the south side of the spillway. Erosion, due to highway runoff, is also active on both the upstream and downstream slopes of the north embankment section. The center section of the dam, which may be natural ground, has sandy soil bare of vegetation, but no significant erosion is taking place. Erosion must be controlled to preserve the long-term stability of the dam. The trees and brush growing on the upstream and downstream slopes of the north section of the dam must also be cut, and the roots removed and properly backfilled.

The dam is assessed to be in overall fair condition.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The dam is currently operated by the Pennichuck Water Works, essentially as a convenient station for the introduction of water chemicals. The chemicals are injected into the stream from a perforated 4" pipe laid atop the crest. Chemicals are contained in a tank housed along with injection perforated 4" pipe laid atop the crest. Chemicals north abutment. Water is allowed to flow unregulated over the spillway, year round. The level is monitored to regulate the chemical injection rate and as a planning aid by the Water Works.

4.2 Maintenance of Dam

The dam shows the effects of conscientious routine maintenance, and presents a good appearance considering its age.

4.3 Maintenance of Operating Facilities

The chemical system is quite new. During one of the inspection visits, maintenance men were performing adjustments on the chemical feed apparatus. The gate for the discharge conduit is reported to be exercised, regularly.

4.4 Description of any warning system in effect

There is no formal warning system in effect.

4.5 Evaluation

Hydraulically, the dam is not really operated, since the water is allowed to flow over the spillway unregulated, year round.

The operation and maintenance of the chemical feed system appears to be adequate.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

As mentioned previously, there are no detailed design data. Criteria for choosing the spillway and discharge conduit sizes are unknown.

b. Experience Data

The memoranda on file concerning the March 1936 flood conflict somewhat on the point of whether overtopping did, in fact, occur or whether it was prevented, by the use of sandbag revetments. The notes do agree that the peak discharge was 525 cfs and is the highest ever recorded. The highest five recorded flow rates are as follows:

Date	Flow Rates
March 1936	525 cfs
March 1956	330 cfs
April 1, 1962	278 cfs
April 6, 1960	272 cfs
March 20, 1968	222 cfs

c. Visual Observations

The highway bridge over the tailwater has a very small waterway opening. This flow constriction could cause backflooding at the dam. It appears quite probable that the bridge would be inundated by a flow less than that necessary to overtop the dam.

Holt Dam actually discharges directly into Bower's Pond and the level of the tailwater is controlled at the Bower's Pond Dam. On each of the several visits made in preparing this report, the tailwater level was quite close to the underside of the highway bridge deck.

d. Overtopping

See Appendix D for the hydrologic computations performed as part of this report.

For dams in the size and hazard classification of Holt Dam, the "100-year" flood is selected as the test flood (or that flood used to evaluate the hydraulic adequacy of a project). The flood of record (March 1936) though relatively low, was selected as reasonably rare based on the climatological event, and is therefore adopted as the test flood. Its peak flow was 525 cfs.

The spillway capacity of Holt Dam, at a pool elevation equal to the top of the dam is about 570 cfs. It can be seen that the spillway can pass the test flood by a small margin.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observation

A lack of vegetation on the south (right) embankment has lead to significant erosion, particularly on the downstream slope adjacent to the spillway training wall. The absence of growth is probably caused by trespassing.

The timber spillway appears to be in good condition. Some underwater grass is growing just upstream of the crest. It could not be observed whether the timber sheeting shown on the drawing (App. B) is actually in place. Vegetation is growing in some of the joints in the stone masonry of the south training wall. Otherwise the stone masonry walls appear in good condition.

The central portion of the dam, around the chemical tank and parking lot is of sandy soil and devoid of vegetation. Very little erosion was noticed here, however.

The north embankment section has a paved highway (Thornton Rd.) on the crest. The upstream slope is covered with grass and, near each end, brush. There was a significant erosion channel from the edge of the pavement down the upstream slope.

The downstream slope is covered with a dense growth of trees and brush. A dry masonry wall, which is in poor condition, runs along the toe of the downstream slope. There is considerable erosion on the downstream slope, despite the dense growth of trees and brush.

b. Design and Construction Data

No design or construction data were found that would assist in evaluating the structural stability.

c. Operating Records

The flood records indicate that the dam has experienced heads at or near the available freeboard, without failure. Extensive work on the dam was undertaken in Nov. 1936, including masonry repairs, timber replacement, and a new gate. It is not clear whether this was to repair damage in the March 1936 flood or not. It may have been precautionary or merely routine work.

d. Post-construction Changes

Significant changes include the gate replacement in 1936 and the chemical feed building and apparatus, within the past decade. The timber spillway sheeting has been renewed several times (no exact records) and the abutments may have been raised slightly in 1938.

Due to the lack of information, it is uncertain whether any of these changes have had an effect on structural stability. The new gate added some margin to the spillway capacity, but not nearly enough to handle severe flood flows.

e. Seismic Stability

The dam is located in a Seismic Zone #2, and hence does not need to be evaluated for seismic stability according to the OCE Rcommended Guidelines.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

Holt Dam is assessed to be in fair overall condition. Trespassing and lack of vegetation have led to active erosion on both the upstream and downstream faces of the dam, and have left other areas susceptible to erosion even where there is no active erosion at the present time. Also, trees and brush on the downstream slope of the north section of the dam could lead to instability if a tree was blown over and its root mass uprooted, or if the roots of dead trees rotted out, providing channels for piping.

b. Adequacy of Information

Very little information exists which is useful to the purposes of this report.

Pond level and high flow records are good. Other useful data such as original plans and construction records and plans of improvement and changes are nearly totally missing.

c. Urgency

The recommendations and remedial measures described below should be carried out the by owner within 2 years after receipt of this Phase I Report.

d. Need for Additional Investigation

There appears no necessity for additional inspections at this time.

This dam should undergo a thorough inspection by a competent engineer once every two years, in addition to regular observation visits by maintenance personnel.

7.2 Recommendations

a. Propose to the proper authorities that engineering studies and design be accomplished regarding replacement of the bridge by one less vulnerable to flood damage.

7.3 Remedial Measures

a. Alternatives - N/A

b. Operating and Maintenance Procedures

(1) Begin keeping permanent records of all construction and physical changes to the dam.

(2) Continue the conscientious observation and maintenance visits and establish and maintain a permanent log book for recording data and notes.

(3) Continue to regularly exercise the gate mechanism and all other moving parts.

(4) Signs to warn approaching highway traffic of the potential flood danger may be advisable.

(5) Place riprap or other slope protection along the full upstream face of the north embankment.

(6) Cut all trees and shrubs on the north embankment between road and the edge of water, on both sides. The area adjacent to the tailwater on the south side should also be cleared of trees. Those trees actually on the dam should be cut and the stumps removed and backfilled under the direction of a competent engineer to minimize the possibility of dead tree roots forming piping channels.

(7) Repair all eroded areas and establish vegetation to prevent reoccurance.

HOLT DAM

APPENDICES

Appendix	Description
A	Visual Inspection Checklist - 7 pp.
B	Engineering Data with Index
C	Inspection Photographs with Index - 12 photos
D	Hydrologic Computation
E	Information as Contained in the National Inventory of Dams

APPENDIX A

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Holt Dam

DATE 6/7/78*

TIME 3:00

WEATHER Warm Sunny

W.S. ELEV. 183.3 U.S. _____ DN.S.

(2" above crest)

PARTY:

1. T.T. Chiang, W&H
2. J. Scott, W&H
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	All Features	Chiang & Scott	
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

* Additional visit performed - see next sheet

Check List combines comments of both visits.

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Holt Dam DATE 7/12/78*

TIME 8:30 A.M.

WEATHER Sunny, Cool

W.S. ELEV. 183.2 U.S. ____ DN.S.

(1" above crest)

PARTY:

1. J. Little, W&H
2. R. Hirschfeld, GEI
3. ____
4. ____
5. ____
6. ____
7. ____
8. ____
9. ____
10. ____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	All Features	Little & Hirschfeld	
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

* Previous visit performed - see previous sheet.

Check List combines comments of both visits.

PERIODIC INSPECTION CHECK LIST

PROJECT Holt Dam DATE 6/7/78 & 7/12/78

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	
Current Pool Elevation	183.3 (6/7) and 183.2 (7/12)
Maximum Impoundment to Date	185.2, March 1936
Surface Cracks	None
Pavement Condition	Thornton Rd. pavement good
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	OK
Horizontal Alignment	OK
Condition at Abutment and at Concrete Structures	Good-some vegetation growing in joints of south training wall.
Indication of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	Considerable trespassing-has worn away vegetation of south embankment. Nice picnic spot
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection-Riprap Failures	None observed
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	Level recorder maintained in gatehouse.

PERIODIC INSPECTION CHECK LIST

PROJECT Holt Dam DATE 6/7/78 & 7/12/78

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	N/A
Bottom Conditions	Some underwater grass in upstream area
Rock Slides or Falls	None observed
Log Boom	N/A
Debris	None observed
Condition of Concrete Lining	N/A
Drains or Weep Holes	N/A
b. Intake Structure	
Condition of Concrete	Water Works engr. says gate works perfectly, recently checked. Inspection team did not observe gate being operated.
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Holt Dam DATE 6/7/78 & 7/12/78

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-CONTROL TOWER	
a. Concrete and Structural	
General Condition	No "control tower". Wood Frame gate house in fair to good condition.
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	Nothing Fancy - a light, power for level recorder, and gate mechanism inside gate house.
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Lightining Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

PERIODIC INSPECTION CHECK LIST

PROJECT Holt Dam DATE 6/7/78 & 7/12/78

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Stone masonry training walls - vegetation in a few joints, alignment good. Tailwater goes under bridge - level controlled from downstream dam. Scum skimmer at bridge opening. Bridge very low.
Rust or Staining	
Spalling	
Erosion or Caviation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

PERIODIC INSPECTION CHECK LIST

PROJECT Holt Dam DATE 6/7/78 & 7/12/78

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Some underwater grass
b. Weir and Training Walls	
General Condition of Concrete	South training wall has some vegetation in joints, otherwise walls good. Timber spillway in good shape.
Rust or Staining	None observed
Spalling	None observed
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	None observed
Drain Holes	None observed
c. Discharge Channel	
General Condition	Good, except for small bridge opening.
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Trees on south side may interfere with high flows
Floor of Channel	Not visible
Other Obstructions	Bridge has skimmer for scum formed with addition of treatment chemical.

APPENDIX B
HOLT DAM
ENGINEERING DATA

Plan sketch

Data sheet on ponds on Pennichuck watershed

Summary of spillway capacities of P.W.W. dams

Sheet of peak discharges and dates

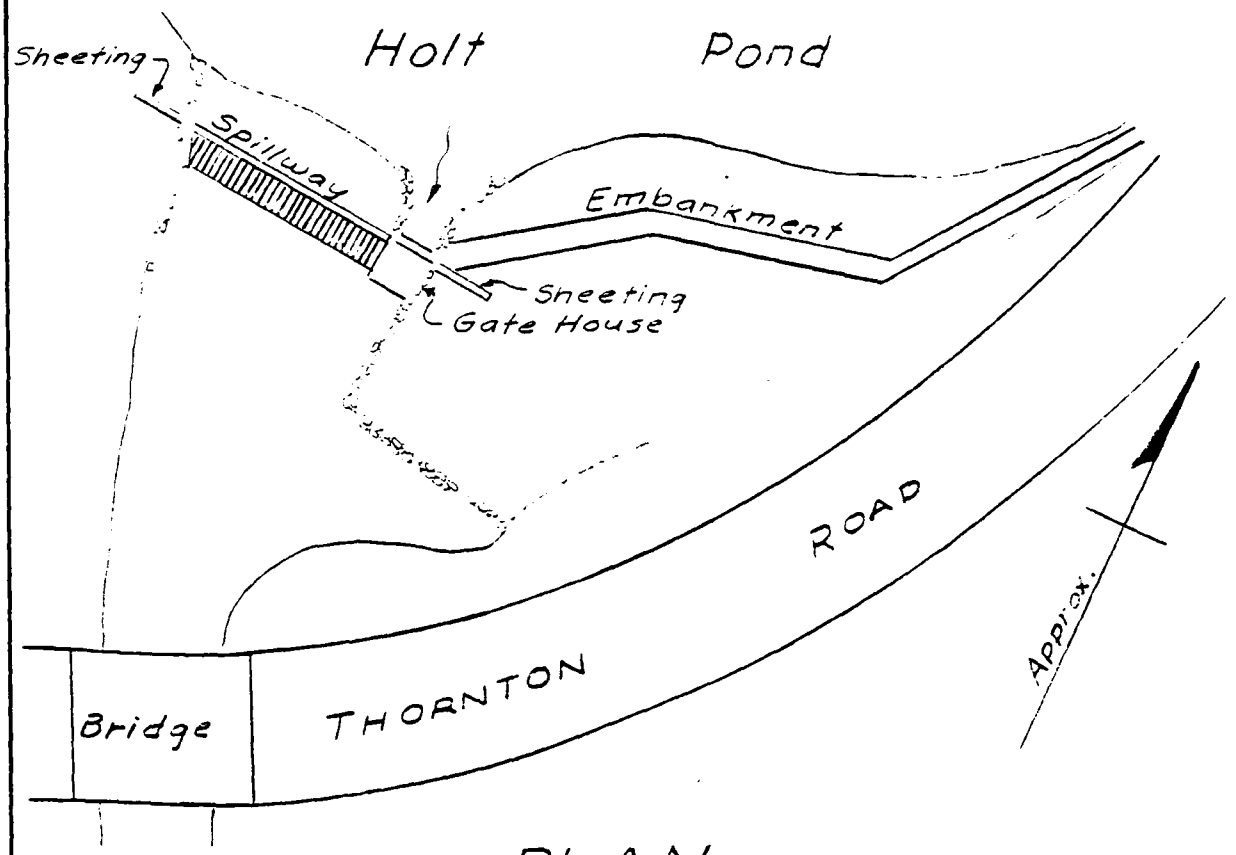
NH Water Resources Board, Dam Safety Inspection Report Form, 10/25/73

Note of 9/10/53 about results of draining Holt Pond

Brief report on spillway capacity and suggested improvement, 2/16/45. (Note: improvements apparently not made).

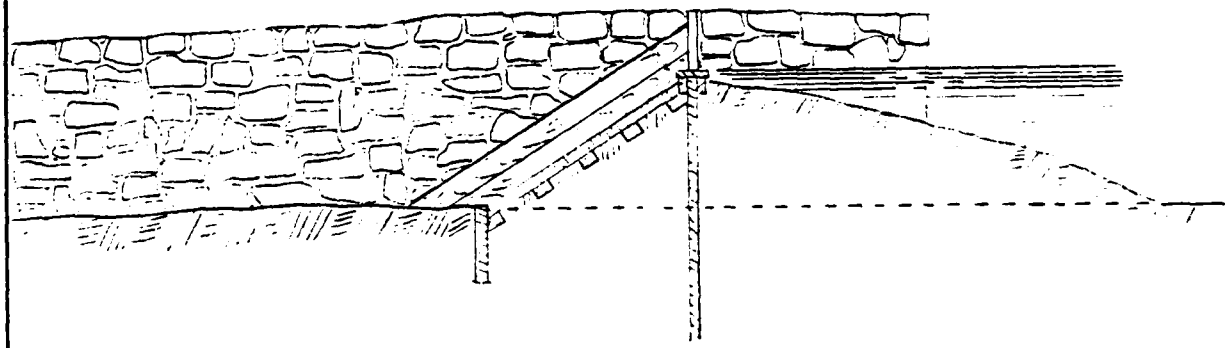
Notes on back of old plan - undated. References to history, 1936 flood and repairs, and 1940 inspection

Spillway rating curve, 6/31, two sheets



PLAN

Scale 30' to 1"



SECTION THROUGH SPILLWAY

Scale 8' to 1"

Traced from print of origina
plan dated Nov. 17, 1914 - as rebuilt in 1890.

WHITMAN & HOWARD, INC.	PLATE
ENGINEERS & ARCHITECTS WELLESLEY, MASS.	

PONDS ON THE WATERSHED OF THE PENNICHUCK WATER WORKS

Pond	Location	Storage Capacity Million Gals.	Surface Area Acres	Drainage Area Sq. Miles	Elevation U.S.G.A.
(a) SUPPLY	Nashua & Merrimack	54.3	17.9	25.36	136.75
(a) HARRIS	Merrimack	375.4	83.3	24.71	167.71
(a) BOWERS	"	248.	87.3	22.99	177.84
(a) HOLT	"	15.	35.+	21.12	183.03
(b) OLD PENNICHUCK	Nashua & Hollis		50.+		186.+
(c) STUMP	Merrimack		12.+	1.65	194.+
(c) DUNCKLEE	Hollis		5.+	1.75	
(d) LONG	"		32.77		274.+
(d) PARKERS	"		6.8		230.+
(d) HAYDEN'S MILL	"		4.+		

(a) Ponds and dams owned, controlled, and maintained by the Pennichuck Water Works.

(b) Owned in part by Pennichuck Water Works.

(c) Dam site and water rights owned by Pennichuck Water Works.

(d) No control by P. W. W. Data shown from State Planning Board.

Summary of Spillway Capacity at Dams

	Drainage Area in Sq. Mi.	Length of Spill-way in feet	Ht. of Top of Embkt above spill-way in feet	Corresp. Discharge c.f.s.	c.f.s. per sq. mile	Remarks
Holt	21.12	38.7	2.67'	560	26	No flash-boards
Bowers	22.99	44 net				
Max. ht. with 5.5' of flashboards			2.0	532	23	Waste gate also forms cir. overflo 4' in dia. included
With 4' of flash boards			3.5	1079	47	
Without flashboards			7.5	3280	143	
Harris (with 2' of flashboards)	24.71	85	5.7	3920	155	
Without flashboards			7.7	6050	242	
Supply Pond Without Flashboards	25.36	30	3.7	710	28	No deduction for obstruction caused by brid

Discharge capacity of the penstock approx. 300 c.f.s.

Flood discharges of streams as small as that of Pennichuck Brook (approximately 25 sq. miles) have frequently been observed exceeding 150 c.f.s. per sq. mile and in some cases exceeding 200 or even 250 c.f.s. per square mile.

PEAK DISHARGE AT HOLT DAM #4

MAR.	1936	525 CFS	(HIGHEST EVER RECORDED)
2 MAR	1956	2 330 CFS	
APR 10	1958	208 "	
APR 5	1959	146 "	
APR 6	1960	+ 272 "	
APR 15	1961	210 "	
APR 1	1962	3 278 "	
APR 5	1964	101 CFS	
APR 12	1965	36 "	
MAR 27	1966	57 "	
APR 5	1967	133 "	
MAR 20	1968	222 "	
MAR 28	1969	170 "	
APR 4	1970	198 "	
APR 4	1971	115 "	
MAR 24	1972	132 "	
APR 3	1973	208 "	
MAR 28	1974	98	

good records of previous floods

4E _____ DATE _____ PROJECT # _____

N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: Nashua Dam Number: 165.03 (Hunt Dam)

Inspected by: JJD Date: 10/25 1972

Local name of dam or water body: Pennichuck

Owner: Pennichuck Water Works Address:

Owner (was)/was not interviewed during inspection.

Drainage Area: ~21 sq. mi. Stream:

Pond Area: 83.2 Acre, Storage Ac-Ft. Max. Head Ft.

Foundation: Type Earth, Seepage present at toe - Yes/No,

Spillway: Type Timber (Concr.) Freeboard over perm. crest: 2.3',

Width 32', Flashboard height None,

Max. Capacity c.f.s.

Embankment: Type, Cover Width,

Upstream slope to 1; Downstream slope 1 to 1

Abutments: Type Soil Stone, Condition: (Good,) Fair, Poor

Gates or Pond Drain: Size 2x3' Capacity Type Timber

Lifting apparatus Manual Operational condition Good

Changes since construction or last inspection:

Downstream development: Downstream Pond

This dam (would)/would not be a menace if it failed.

Suggested reinspection date:

Remarks: This site is used to inject Alum into stream - Some splinter leaks H2O Elevation at time of inspection = 0.10' above weir Permanent registration

Sept 10, 1953

Drained Holt Pond into Bowers.

Water rose 0.5-5' in Bowers. This indicates that Holt Pond contains about 15 mil gals.

2-16-45

HOLT DAM

Spillway Discharge Capacity

The maximum discharge capacity of the spillway at Holt Dam is now about 560 CFS which is equivalent to 26 CFS/ sq. mile. Present day engineering design provides for a much higher maximum discharge and new well designed structures on streams similar in character to Pennichuck Brook should provide for a flood flow of 150 CFS/sq. mile, nearly six timesthe present capacity of the spillway at Holt Dam.

This dam was built between 50 and 60 years ago and has withstood the floods of the intervening years, therefore a design providing for flood flows as high as 150 CFS/ sq. mile may be unnecessary. We do know from past experience that the present spillway capacity is not adequate and that during the flood of March 1936 sandbags had to be used to keep the embankments from being overtopped.

Suggested Improvements

The present spillway is 38 feet long and is at elevation 183.00. The freeboard, or maximum height to which water can go without overtopping the embankments,is 2.67 feet, this allows a maximum discharge of about 560 CFS. By increasing the height of the embankments and portions of the retaining or wing walls to elevation 188.00 (a maximum increase of 2.33 feet) the flood descharge capacity would be increased to about 1600 CFS or 76 CFS/sq. mile, nearly three times the present discharge capacity.

At the southwesterly or Nashua end of the dam this increase in freeboard could be accomplished by building a short wall of field stone set in cement and then placing earth fill against the downstream face of the wall to give it stabality. This very simple and inexpensive construction as the maximum height of the wall would be only slightly over two feet above the present ground surface.

At the northeasterly or Merrimack end of the dam a wall of similar construction about 180 feet in legnth would have to be built. For most of this distance this wall would only have to be built about one foot above the present grade. This new wall would tie into the present masonary wing wall of the dam near the gate house and provision would have to be made to protect the gate house from flooding.

Construction as outlined above is comparatively inexpensive, could be done with our own men, there would be practically no expense for materials, and most important of all would provide adequate spillway capacity at one of the bottle necks on our drainage area.

These improvements apparently never done.

Original dam - probably prior to 1840

Purchased 1866

flowed area approx 35 acres

approx capacity 35 million gals.

Rebuilt ~~1870~~ July - 1900

Spillway = 38' - 38.7' - (1.3')

Max. depth of water over crest without overtopping = 2.67' or a discharge capacity of 560 cu. ft/sec. - or 26 cu. ft/sec per square mile.

Cal - Div - 193.03 U.S.G.S.

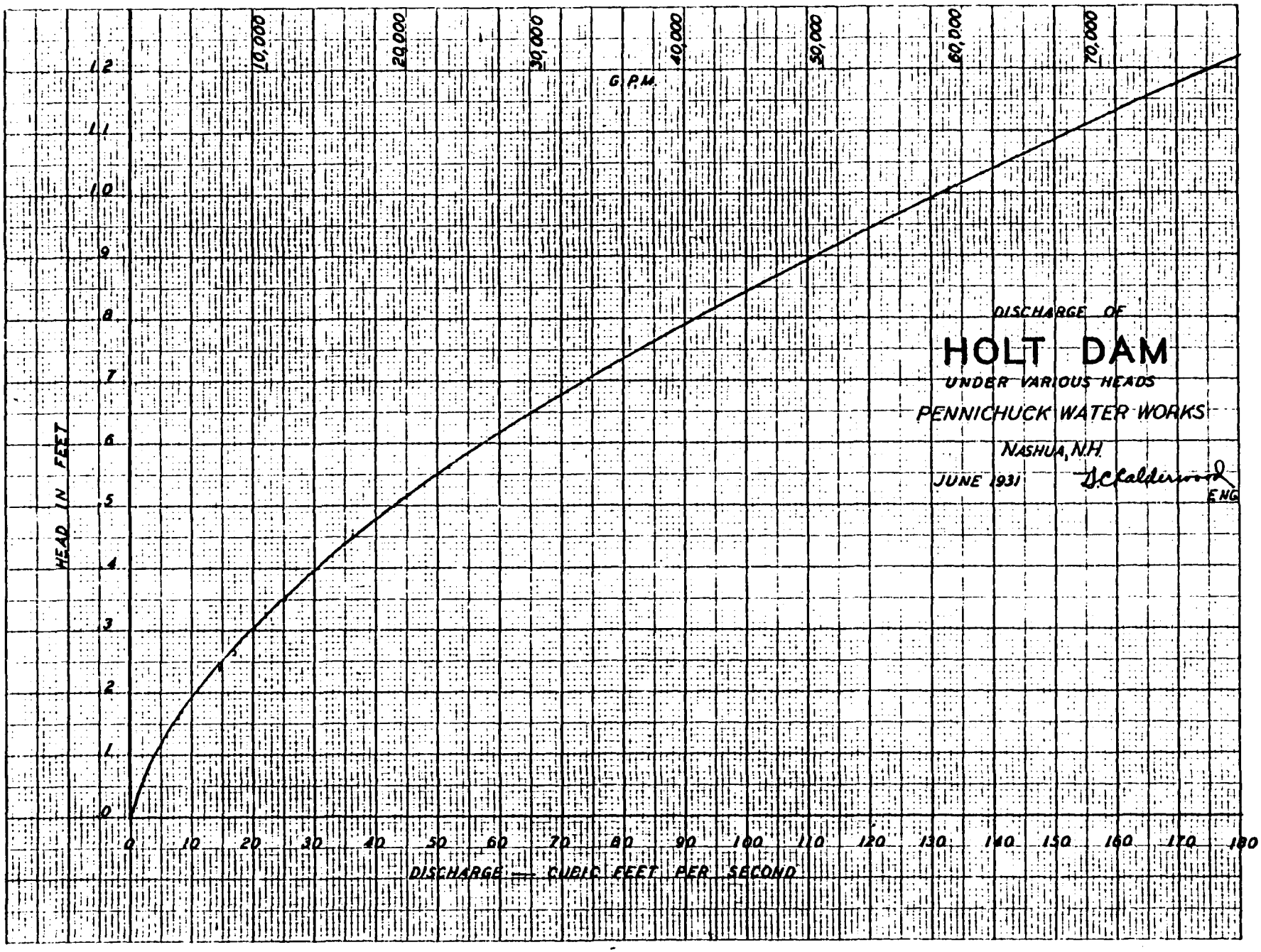
Extensive repairs made - November 1936

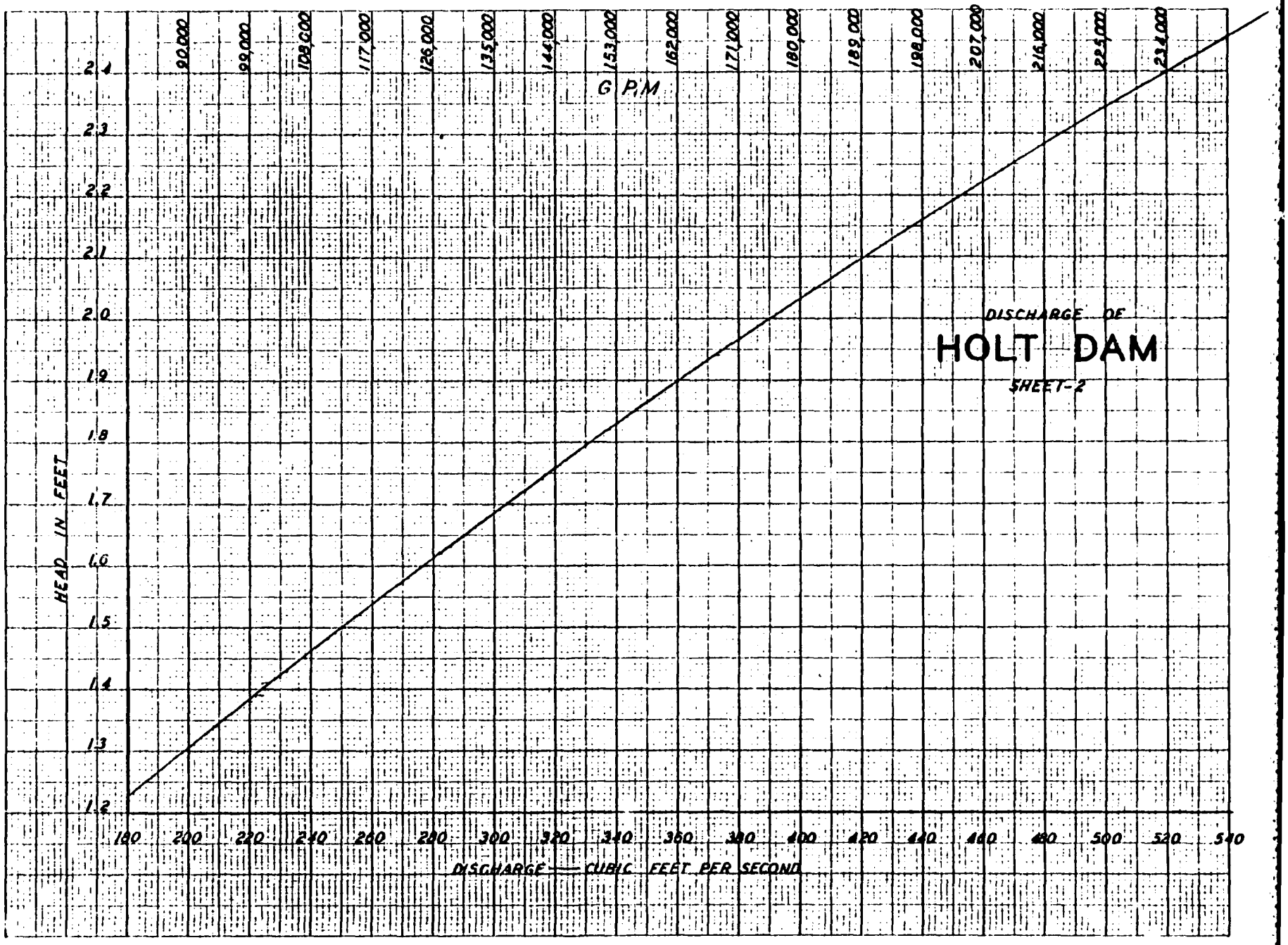
Filled in around toe of dam with cement. - Cemented space between abutment and gate house, built additional cement retaining wall around east abutment - pointed up retaining walls, etc in all about 100 bags of cement used.

Also new planking placed on toe of dam - a portion of the sheathing (7/8") in the flume was renewed - and the location of the gate itself was changed in relation to the flume

New gate 2'2" x 3' = 6½ sq. feet

INSPECTED - JUNE 18 - 1940
BY ENGINEER FOR WATER RESOURCES BOARD. - NOTED - NO HAZARD
WILL NOT BE SUBJECT TO FURTHER INSPECTIONS


G.P.M.
10,000
20,000
30,000
40,000
50,000
60,000
70,000
HEAD IN FEET
0
1
2
3
4
5
6
7
8
9
10
11
12
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
DISCHARGE — CUBIC FEET PER SECOND
DISCHARGE OF
HOLT DAM
UNDER VARIOUS HEADS
PENNICHUCK WATER WORKS
NASHUA, N.H.
JUNE 1931
J.C. Calderwood
ENG


90,000
99,000
108,000
117,000
126,000
135,000
144,000
153,000
162,000
171,000
180,000
189,000
198,000
207,000
216,000
225,000
234,000
G P M
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
HEAD IN FEET
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
DISCHARGE — CUBIC FEET PER SECOND
DISCHARGE OF
HOLT DAM
SHEET-2

APPENDIX C
HOLT DAM
INSPECTION PHOTOGRAPHS

Photo No.	Description
1.	Looking upstream from bridge showing from left to right; south embankment & south training wall, timber spillway, white gate house, stone retaining wall and green chemical feed building. Scum in tailwater, foreground, is residue from chem. treatment. 6/7/78.
2.	Looking downstream at Thornton Rd. bridge from dam. Note high tailwater in relation to bridge opening- scum skimmer in place under bridge Bowers Pond in background. 6/7/78.
3-4	Sequence of 2 photos taken down and to the right from downstream slope of south embankment showing: erosion of soil from earthfill downstream of masonry wall (at top of Photo 3) between south abutment and spillway, top of masonry training wall on south side spillway, detail of erosion at lower part of slope and downstream end of training wall, with backwater (blue area at right of #4) below spillway and water discharging down spillway face (gray-brown area in upper rt. of #4) 7/12/78.
5	Looking across crest to south abutment. Timber spillway in good condition - vegetation growing in some joints of training wall. 7/12/78.
6	Looking at north end of spillway showing white gate house, stone masonry wall, green chemical feed building in background, and bare surface area around buildings. Thornton Rd. in background. 6/7/78.
7	Looking at parking area - note sandy, bare surface. 7/12/78
8	Looking upstream at dry masonry wall of downstream face of north embankment. Extensive tree and brush growth, wall in poor condition. 6/7/78.

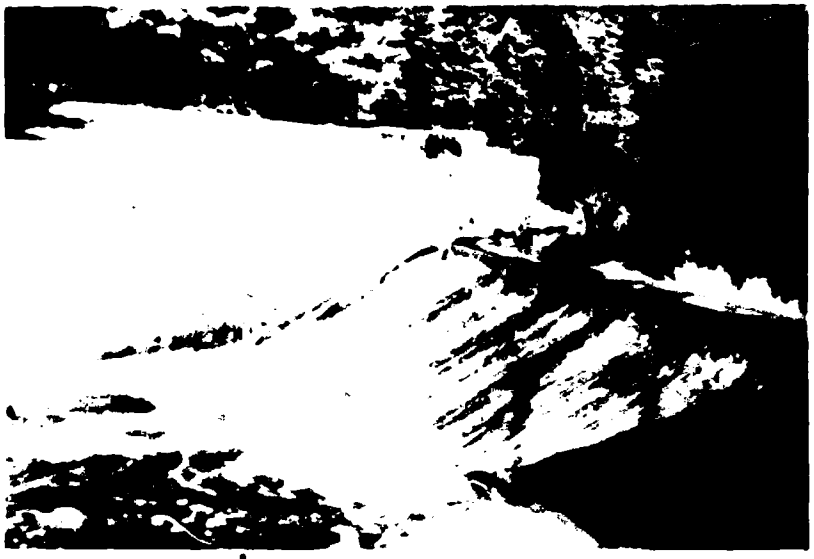
Photo No.	Description
9-10	Two photos looking along upstream face of north embankment. No. 9 taken 6/7/78 and No. 10 taken 7/12/78. Note erosion hole (bottom rt. of no. 10 with metal clip-board) which was formed by roadway runoff in the intervening 35 days.
11-12	Two photos clockwise sequence looking upstream at trees on south embankment and Thornton Rd. bridge.

1

2

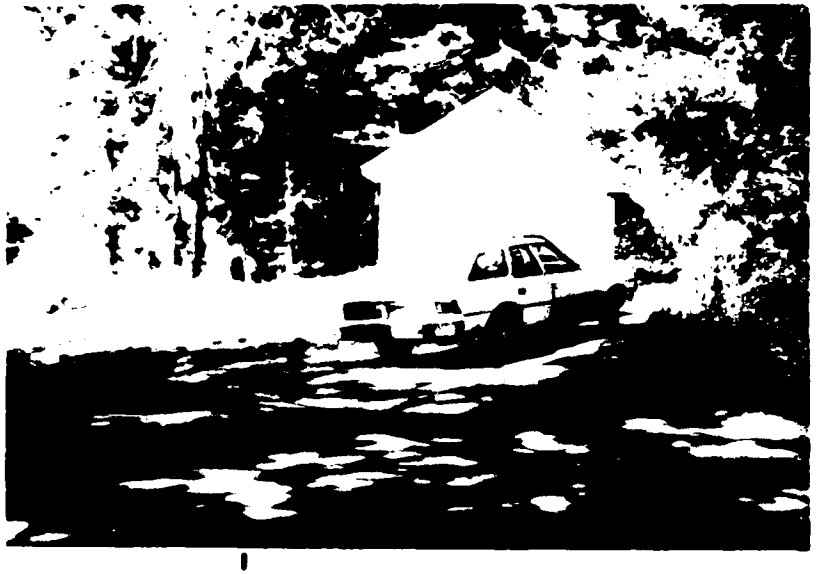
3

4



5

6



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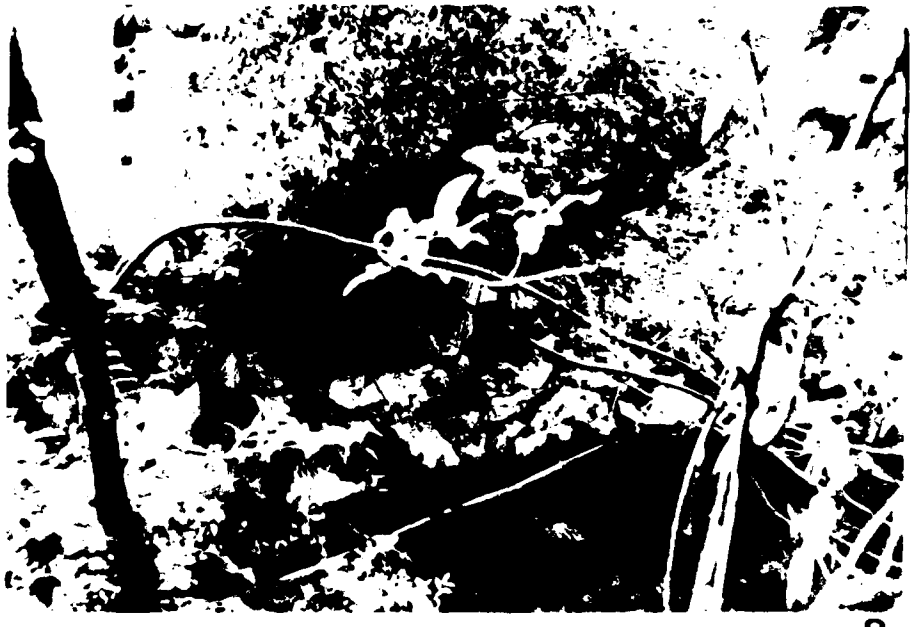

8

9

10

11

12

APPENDIX D

HYDROLOGIC COMPUTATIONS

WATERSHED MAP

BY T.T.C. DATE July 78 PROJECT Army Corps Engrs SHEET NO. 1 OF 3

CHKD. BY ..... DATE ..... Dam Safty Inspection - Holt Pond JOB NO. B-081

Holt Pond Dam : Located on Penrichuck Brook
Timber, earth & Rock fill dam with
Rock & concrete abutments
Height of Dam 185.2 - 174 = 11.2 Ft.

I. Hydrology & Hydraulic Conditions.

a) Drainage Area: 21.1 Sq. Mile

b) Basin characteristics: Rolling land at upstream of the basin; flat near the Pond. There are several small ponds upstream, but do not seam to have any higher dam at all.

c) Water surface Area: About 35 Acres, at spillway crest. Top of the Dam only about 2 ft. higher than the spillway.

d) Storage Capacity: No data available about the storage capacity. It has been drained into Bowers Pond during 1953. Rise in Bowers Pond indicates only 15 M.G., but record did not indicate what level the Holt Pond was, before draining.

By using the known structure height of 8', with water surface area of 35 acres, the estimated storage is about 180 Acre-Ft. at spillway crest elevation and is about 240 Acre-Ft at elevation equal to top of dam.

It belongs to <u>small</u> dam category

e) Probable Maximum Flood Flow

By using about 900 cfs/Sq. mile, the
MPF = 18,990 cfs, say <u>19,000</u> cfs
½ MPF = 9500 cfs
During 1936, the flood flow is estimated at a rate of 500 - 600 cfs, which would overtop the

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45 WILLIAM STREET, WELLESLEY, MASS.
Engineers and Architects

dam, if it were not sand bagged. The 1936 flood is considered as hundred year flood, generally. So, the spillway capacity is considered adequate due to Low Hazard classification.

f) Spillway Capacity.

The existing 38.7 ft in length timber spillway, with gross freeboard of 2.6 ft, does not have any capacity based on present standards and considering wave height. (2.6 ft Freeboard).

By neglecting wave action, due to the shallow pond, the maximum spillway capacity only amounts to $Q = 3.5 \times 38.7 \times 2.6^{3/2} = 570$ cfs. Due to its small water surface area, surcharge effect is negligible.

At downstream of the spillway, there is an existing bridge. It is in very poor shape, and also does not have capacity to pass flood flow.

g) Comments & Conclusions:

(i) The tailwater, Bowers Pond, is only a few feet lower than the Holt Pond; overtopping may not create a hydraulic force to wash the dam away. Spillway is considered adequate due to low hazard condition.

(ii) Most part of the dam is used as a roadway, and is paved; maintenance of the roadway would help the dam's stability. Paving the parking area near Gate House would help to protect that section of the dam.

(iii) With its storage capacity so small, even dam failure would not create any significant hazard. The spillway and gate house section failure may cause the immediate downstream bridge to be washed out, which in our opinion, is part of the dam and is in a condition requiring reconstruction, anyway.

(iv) The roadway, on left side of gate house (facing downstream), should be considered as part of the dam and its upstream surface should be riprapped. The downstream face has riprap, but tree growth is

very thick. It will block flood flow during overtopping. To prevent increased damage on the dam, those trees should be cut down so when overtopping, the flood flow could become thin overland flow passing over the top of dam.

(ii) Warning signs concerning flood problems should be installed on both ends of the street at higher ground, (so to avoid during storms) people driving by the top, when it may be overtopped.

II.) Other Comments

a) It is not advisable to raise the existing roadway elevation, since it seems uneconomical to try to construct a spillway long enough to pass the flood flow, if MPF or ½ MPF occurs.

b) The Flocc which forms between the spillway and the bridge should be clean up from time to time.

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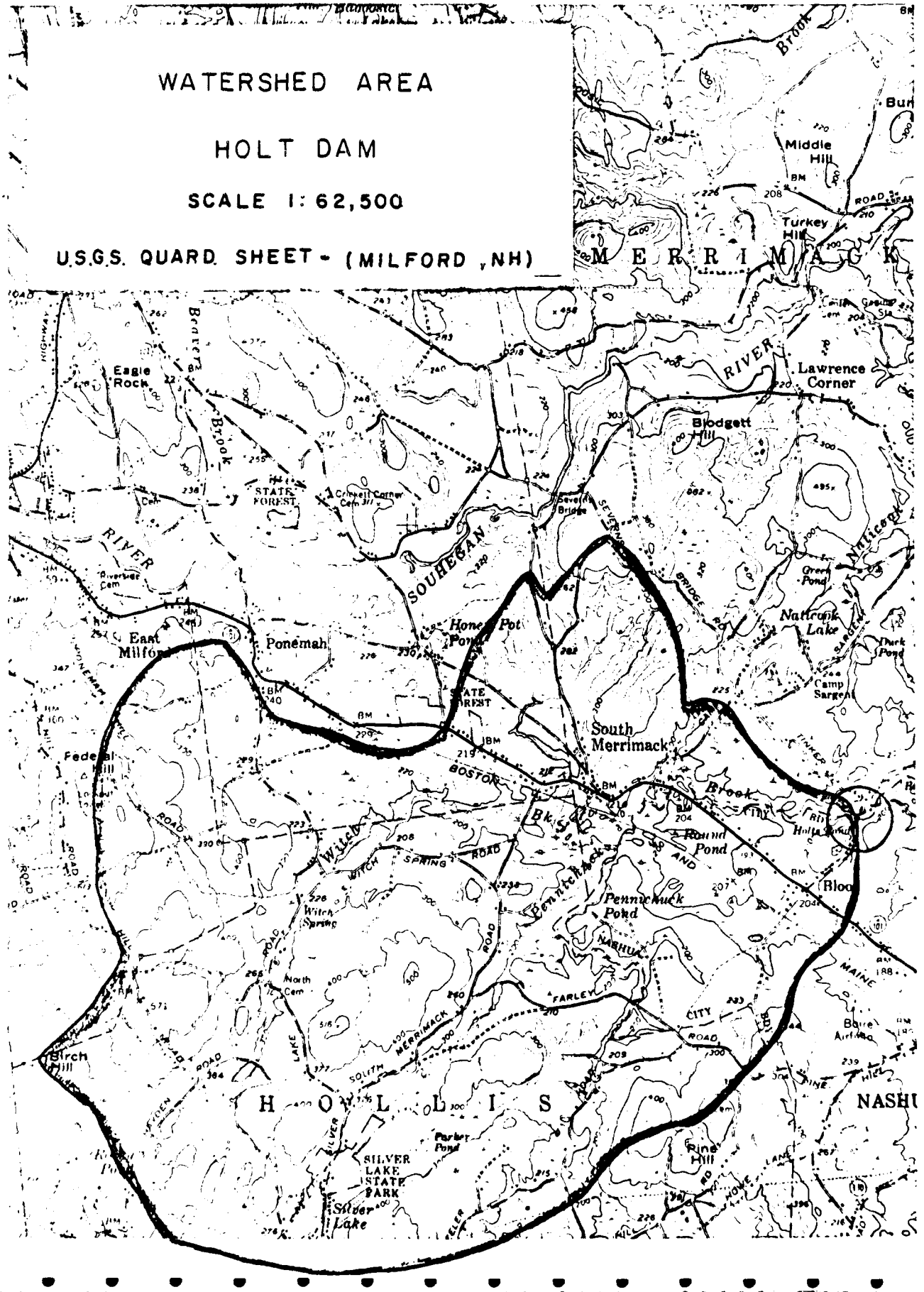
45 WILLIAM STREET, WELLESLEY, MASS.
Engineers and Architects


WATERSHED AREA
HOLT DAM
SCALE 1: 62,500
U.S.G.S. QUARD. SHEET - (MILFORD, NH)
M E R R I M A C K
H O L L I S
NASHU
Middle Hill
Turkey Hill
Eagle Rock
Lawrence Corner
Blodgett Hill
East Milford
Ponemah
South Merrimack
Federal Hill
Birch Hill
Round Pond
Pennichuck Pond
Silver Lake
Pine Hill
Natticook Lake
Camp Sargent
SILVER LAKE STATE PARK
STATE FOREST
RIVER
SOUHEGAN
BOSTON
NASHUA
FARLEY
MERRIMACK
SOUTH
WILD WITCH SPRING ROAD
CITY ROAD
MAINE

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

END

FILMED

8-85

DTIC